2013

Soybean Management Field Days

RESEARCH UPDATE

Sponsored by:

University of Nebraska Lincoln EXTENSION

In partnership with:

Soybeans Nebraska Soybean Board

Our Soy Checkoff
Progress Powered by U.S. Farmers

IANR

University of Nebraska–Lincoln
Institute of Agriculture and Natural Resources

March 2014

Soybean Management Field Days
On-Farm Research
Introduction

Keith Glewen, UNL Extension Educator

The 2013 growing season represented the third year replicated field research was conducted at the Soybean Management Field Day locations.

Why the need for conducting on-farm research at these locations?

Many practical questions regarding soybean production and natural resource sustainability are not being answered by current federal and industry funded crop research programs. In addition, the diversity of soybean growing environments in Nebraska, changes in climate and advancements in production technologies are causing growers to question many long-held assumptions associated with soybean production. Add to this, today's consumer are asking questions about how and where their food comes from, the increasing world demand for soybeans, and the importance natural resources such as soil and water has on meeting this growing demand. Subsequently, growers are increasingly challenged to grow soybeans more responsibly and to document sustainability.

Faculty and staff representing the University of Nebraska – Lincoln greatly appreciate the financial investment you the soybean growers of Nebraska have made through your Checkoff contribution in supporting the research undertaken in this project. We would also like to thank the Nebraska Soybean Board for their part in support and management of this effort. Their input into the selection of research topics and in some cases treatments, was extremely valuable.

TABLE OF CONTENTS

Use of commercial and trade names does not imply approval or constitute endorsement by the University of Nebraska-Lincoln Extension. Nor does it imply discrimination against other similar products.

Soil textures and overall crop management at each location of the 2013 SMFD study

Location	Soil Textures	Planting Date	Herbicide Program Date	Herbicide Program Chemical and Rate/A	Harvest Date	Trial Avg. Yield (bu/A)
Minden	0-8": silt loam 8-24": silty clay loam 24-48": silty clay loam-silt loam	5/13/2013	6/11/2013	Outlook 18 fl oz Pursuit 4 fl oz Roundup + AMS 28 fl oz	10/17/2013	76.7
			7/8/2013	Roundup + AMS 28 fl oz		
Pierce	0-8": sandy loam 8-24": sandy loam-loamy sand 24-48": loamy sand-sand	5/15/2013	6/13/2013	Outlook 18 fl oz Pursuit 4 fl oz Roundup + AMS 28 fl oz	10/25/2013	71.4
			7/7/2013	Roundup + AMS 28 fl oz		
Waterloo	0-8": sandy loam 8-24": sandy loam 24-48": sand	5/17/2013	6/12/2013	Outlook 18 fl oz Pursuit 4 fl oz Roundup + AMS 28 fl oz	10/10/2013	60.9
			7/8/2013	Roundup + AMS 28 fl oz		
York	0-8”: silty clay loam 8-24": silty clay loam 24-48": silty clay loam	5/14/2013	6/17/2013	Outlook 18 fl oz Pursuit 4 fl oz Roundup + AMS 28 fl oz Clethodim 9 fl oz	10/18/2013	74.3
			7/8/2013	Roundup + AMS 28 fl oz		

Effect of High Rates of Nitrogen on Soybeans

Authors: Charles Shapiro (UNL Extension Soil Scientist – Crop Nutrition),
Loren J. Giesler (UNL Extension Plant Pathologist)

TAKE HOME POINTS:

- SMFD field day sites in 2013 had adequate fertility for high yields
- Soil textures ranged from silty clay loam to loamy sands and represented the soil resources in Nebraska
- Large doses of nitrogen additions increased yields, but not at every site
- These yield increases at present prices would not be profitable
- Residual soil nitrates at the end of the season in the high N rate treatments creates potential for nitrate leaching
- Large nitrogen additions increased protein at 3 of 4 locations, but the increase was less than 1%

Introduction

The desire to achieve high yields in soybeans continues to challenge researchers and producers, alike. There are many ideas on what is holding back yields, and what might increase them. It is impossible to test all the ideas in one study, yet there maybe combination effects that are missed in a single factor study, so there is a place for both studies. In this study, the focus is on very high nitrogen rates. The idea was that if we can document increased yields with very high rates, we could then figure out how to get similar yields with less nitrogen. Past studies in Nebraska have used nitrogen rates under 100 lbs/acre and have reported only modest yield increases of less than 3 bushels, very inconsistently.

Methods

This study was a small 'side study' that was conducted in conjunction with the larger study reported elsewhere in this publication. The large factorial study could only look at with or without the use of nitrogen and a few other nutrients. In this study we focus on trying to increase yields with high rates of nitrogen. There were no fungicide/insecticide seed treatments. Nitrogen (N) rates were applied as listed in the tables. The experiment was a randomized complete block with 4 replications. The early N source was 28 % UAN when applied at V2, the N was applied with drop nozzles between the rows. Urea and was dribbled by hand between the rows at R3. Most of the cultural practices were similar to the ones in the factorial study. Row spacing was 30 in, in addition to the nitrogen treatments the same N Rage™ and Soy Grow™ (Nachurs) rates were applied to this study as were treatments in the larger study.

The data collected was a one-time reflectance scan with a Rapid Scan (Holland Scientific, Lincoln, NE) at the time of the Soybean Management Field Days (mid-August), grain yield, and post-harvest soil samples. The Rapid Scan is a reflectance meter that is used to determine several vegetative indexes that can be used in assessing dry matter and relative greenness. Soybean seed samples sent to UNL and the soils to Ward Laboratories (Kearney, NE) for analysis. Seeds were analyzed for protein, oil and fiber. Soil samples were taken from each experimental unit with a Giddings soil probe. Two cores were combined for depths 0-12 in, 12-24 in, and 24-48 in. Results from the lab are in ppm, but they are reported here as lbs/acre. A general soil sample for the 0-8 in horizon was taken across all replications at all sites, except Waterloo. The results of the general soil sampling are in Table 1. There were no obvious nutrient deficiencies, and the pH was in an acceptable range for soybean production.

Results

The Rapid Scan data did not show significant results, and are not reported here. The yield data is where most interest is focused. In table 2, the yields by location are presented with the results of the ANOVA, which helps us distinguish important treatment effects. Yields were different at several sites, with Waterloo being the lowest yielding. This was due to it being on a creek bottom, with high sands, and high variability. From the beginning of the season, plant height variability was noticeable and it was not necessarily correlated with treatments. The individual location analysis indicated two sites (Pierce and York) where there was significant yield effects, with the two highest N rates (300 and 400 lbs N/acre) increasing yields over the control. When the sites were combined there was a moderately significant (Prob. > F 0.095) trend towards increasing N increasing yields. These yield increases were not economical to use, but the main goal was to determine if yields could be 'pushed' higher. The results are consistent with previous work where there are inconsistent yield increases with added nitrogen. There were no yield reductions with added N.

The grain quality was not affected too greatly, although there were a few significant effects. Protein differed at each location, and there was a slight increase in percent protein at the high N rates, but the differences were not of practical importance (Table 3). Oil content was not much affected, but there were location differences, and at Minden the percent oil decreased with increasing nitrogen applied. Generally, as protein goes up oil went down (Table 4). There were no effects of fiber and the average content for the four locations was 4.7 %.

The final four tables show the effect of treatments on soil nitrate levels. They are presented with the 0-48 in total nitrate nitrogen first (Table 5). A few points can be noted: there are differences by location, but the trends are similar. The individual layers are presented since they show where the N was found. The bulk of the N for treatments 4 and 5 were applied in August, and significant amounts leached into the subsurface. The amount recovered is very high, and this is not a recommended practice.

Discussion

Yields were slightly increased, but soybean quality was minimally affected. The slight yield increases, up to 5 bushels took a lot of nitrogen, up to 80 lbs per bushel increase. The removal of 5 bushels soybeans contains less than 20 lbs of nitrogen, applying 400 lbs to get this increase is not economical, not efficient, and not environmentally sound since up to half of that nitrogen remained in the soil. The goal is to devise a strategy to get a 5 bushel increase without the very large nitrogen load.

Table 1. General fertility level of soybean nitrogen study after harvest (mean of 4 samples, ppm unless noted.)

(Waterloo surface samples not taken)				
	Minden	**York**	**Pierce**	**Waterloo**
CEC (me/100g)	17.4	25.7	10.6	
% H Sat	11	0	18	
% K Sat	10	4	5	
% Ca Sat	59	76	65	
% Mg Sat	18	18	11	
% Na Sat	2	1	0	
pH	6.3	6.7	6.5	
Buffer pH	6.8	7.2	6.8	
1:1 S Salts (mmho/cm)	0.49	0.54	0.12	
OM (%)	3.2	2.6	1.4	
Nitrates (ppm)	13.4	8.6	2.2	
Nitrates (lbs/8 in)	32	21	5	
P (Mehlich 3)	217	16	51	
K	692	450	211	
Sulfate	45	17	12	
Zn	5.81	1.64	5.48	
Fe	79.1	33.5	60.9	
Mn	12.2	12.9	14.8	
Cu	1.36	0.86	0.85	
Ca	2037	3919	1379	
Mg	381	552	145	
Na	72	75	9	
Texture				
Texture (0-8")	Silt loam	Silty clay loam	Loamy sand	Sandy loam
Texture (8-24")	Silt loam	Clay loam	Loamy sand	Sand
Texture (24-48')	Silt loam	Silty clay loam	Sand	Sand

Table 2. Effect of six nitrogen treatments on soybean yield at four locations (bu/ac). 2013

TRT #	Total N rate lbs N/acre	At planting/early (V2)	Mid season R3	Minden	Pierce	Waterloo	York	Means
1	0	0	0	83.3	76.3	52.0	81.9	73.4
2	100	100	0	85.6	79.8	53.2	84.9	75.9
3	100	0	100	83.8	79.1	54.0	79.2	74
4	200	100	100	84.7	80.5	41.1	82.8	72.3
5	300	100	200	87.2	84.5	48.8	85.5	76.5
6	400	100	300	87.4	85.2	56.4	86.7	78.9
Means				85.3	80.9	50.9	83.5	
			Prob > F	0.45	0.008	0.6	0.05	0.095
			CV (%)	4.1	3.8	24.7	3.8	9.2
			LSD 0.05	5.2	4.6	19.0	4.8	
							Loc	<.0001
							Loc x Trt	0.69

Table 3 . Effect of six nitrogen treatments on soybean seed protein at four locations (%). 2013.

TRT #	Total N rate lbs N/acre	At planting/early (V2)	Mid season R3	Minden	Pierce	Waterloo	York	Mean
1	0	0	0	35.5	35.8	35.4	35.0	35.4
2	100	100	0	35.4	35.6	35.6	35.0	35.4
3	100	0	100	35.6	35.4	35.6	34.8	35.4
4	200	100	100	36.1	35.7	36.5	35.5	35.9
5	300	100	200	36.2	35.7	36.8	35.0	35.9
6	400	100	300	36.1	35.7	36.6	35.4	35.9
			Mean	35.8	35.6	36.1	35.1	
			Prob > F	0.06	0.91	0.03	0.06	<.0001
			CV (%)	1.2	1.3	1.6	0.9	1.2
			LSD 0.05	0.6	0.7	0.9	0.5	
							Loc	0.002
							Loc x Trt	0.15

Table 4. Effect of nitrogen treatments on soybean seed oil (%). 2013.

TRT #	Total N rate lbs N/acre	At planting/early	Mid season R3	Minden	Pierce	Waterloo	York	Mean
1	0	0	0	19.50	19.25	18.98	20.00	19.43
2	100	100	0	19.58	19.30	19.05	20.08	19.50
3	100	0	100	19.30	19.43	18.98	20.15	19.46
4	200	100	100	19.10	19.35	18.46	19.95	19.21
5	300	100	200	19.38	19.53	18.15	20.08	19.28
6	400	100	300	19.13	19.40	18.80	20.00	19.33
			Mean	19.3	19.4	18.7	20.0	
		Trt	Prob > F	0.0074	0.6676	0.338	0.6981	0.1407
			CV (%)	0.9	1.3	3.2	0.9	1.7
			LSD 0.05	0.26	0.36	>0.95	0.28	
							Loc	0.0004
							Loc x Trt	0.13

Table 5. Effect of nitrogen treatments on end of season soil nitrates (lbs/ac). 2013.

				0- 48 in profile				
TRT #	Total N rate lbs N/acre	At planting/early	Mid season R3	Minden	Pierce	Waterloo	York	Mean
1	0	0	0	36	24	39	20	30
2	100	100	0	55	22	54	29	40
3	100	0	100	53	33	113	29	57
4	200	100	100	96	40	153	63	88
5	300	100	200	146	72	224	92	133
6	400	100	300	219	116	261	163	190
		Location LSD	29					
			Mean	101	51	140	66	
		Trt	Prob > F	0.0003	0.0014	0.0069	0.0001	0.0001
			CV (%)	44	54	57	36	55
			LSD 0.05	68	41	121	35	35
							Loc	0.0004
							Loc x Trt	0.36

Table 6. Effect of nitrogen treatments on end of season soil nitrates (lbs/ac). 2013.

				Surface 12 inches				
TRT #	Total N rate lbs N/acre	At planting/early	Mid season R3	Minden	Pierce	Waterloo	York	Mean
1	0	0	0	15	5	12	7	10
2	100	100	0	20	6	17	7	12
3	100	0	100	20	7	47	8	20
4	200	100	100	42	6	58	13	30
5	300	100	200	55	8	102	28	48
6	400	100	300	80	27	101	52	65
		Location LSD	14					
			Mean	38	10	56	19	
		Trt	Prob > F	0.004	0.03	0.035	0.0001	0.001
			CV (%)	55	96	77	37	81
			LSD 0.05	32	14	66	11	18
							Loc	0.001
							Loc x Trt	0.135

Integrated Evaluation of Common Inputs To Increase Soybean Yield in Nebraska (2013)

Authors: Charles Shapiro (UNL Extension Soil Scientist – Crop Nutrition),
Loren J. Giesler (UNL Extension Plant Pathologist)

Research Team: Nicholas Arneson (UNL Extension Technologist-Plant Pathology),
Steve Spicka (UNL Agricultural Tech III), Greg Kruger (UNL Cropping Systems Specialist),
Thomas Hunt (UNL Entomologist), Lowell Sandell (UNL Extension Educator),
Kent Eskridge (UNL Statistics Professor), Keith Glewen (UNL Extension Educator)

TAKE HOME POINTS:

- Row spacing generally increases soybean yields, but as the 2013 studies showed exceptions to the rule can be found
- Fungicide seed treatments increased population slightly, but did not increase yields
- There was low insect and disease pressure, and no effect on yield of fungicide or insecticide treatments were identified
- Addition of low doses of nitrogen either at V2 or R3 and a micronutrient mix at R3 did not increase yields

INTRODUCTION

Soybean farmers continue to try various strategies to increase soybean yields. The most commonly tried inputs include row width, seed treatments, foliar fungicide and insecticide applications at pod set, and varying levels of fertility. Soybean farmers and researchers have had varying success improving yield with these inputs. In past years of the Soybean Management Field Day trials, we have evaluated different products and/or treatments within several of these input groups. However, we have not tried putting some of these strategies together in the same experiment. Even though it adds complexity, in 2013 we designed, what we call, an Integrated Study to examine the combined effect of using multiple inputs. Briefly below we will describe our logic in choosing the inputs we included.

Nitrogen application to soybeans has been studied with mixed results for the past 40 years. The logic is that in very high yield situations the nitrogen contributions from the soil and that fixed by the plant can't supply enough nitrogen. Some studies have shown increases, others have not. Nitrogen use is recommended in situations where nodulation is not expected or as insurance when cropping ground that has not been in soybeans before or for a long time. The challenge has been to not inhibit the symbiotic bacterial fixation of nitrogen, but to supplement it. This has led to later season timing of nitrogen application in the R1-R3 range. To determine the value of early season nitrogen, when soil conditions inhibit nitrogen mineralization or soils levels are low, and symbiotic nitrogen fixation is not established, we included an application of early nitrogen (V2) to two of the at planting treatments. To address the mid-season nitrogen question nitrogen was included in several of the foliar treatments.

In addition to nitrogen, some have suggested that soybean yield will be enhanced by foliar application of micronutrients in mid-season. Nebraska soils tend to have sufficient micronutrients, with the exception of zinc and iron in some areas. However, there could be a period of rapid growth where the soybean plant might need more of a specific nutrient than what the soil can supply. It has also been suggested that micronutrients can stimulate growth, which would cause the soybeans to use more of other nutrients, and subsequently increase yields. To address this need, a mix of foliar micronutrients was applied wherever the nitrogen was applied midseason.

Seed treatments are becoming more common with soybean farmers. This input is critical for fields with a history of stand problems but not all fields in Nebraska will benefit from use of a seed treatment. When making product comparisons it is important to make sure there are not significant chemistry changes when one selects an added insecticide treatment. Many companies continue to market new combinations that typically shift some aspect of the fungicide composition with an added insecticide for their “full protection” product. To address this input category we had a seed treatment fungicide combination treatment with and without an insecticide.

Foliar fungicide and insecticide applications at the pod set (R3) growth stage have been evaluated in several studies in Nebraska with varying results. In 2011, we observed an average of 2.1 bu/A yield increase for a fungicide application and this was nearly doubled (4.1 bu/A) when the insecticide was added. In 2012, there was no effect observed with these applications. Across the North Central Region many are showing positive results with the combination of a fungicide and insecticide at the R3 timing. These applications are typically made in the absence of any measurable disease or insect pressure. This is not consistent with integrated pest management strategies, but is a practice many farmers are adopting. To address the R3 fungicide and insecticide application input we have a fungicide containing a strobilurin fungicide with and without the insecticide.

After the evaluation of several kinds/brands of treatments over the past years, we have selected a representative treatment for each input. Products chosen do not indicate that the University of Nebraska endorses them over others, just that they fit the specifications of our project. *The goal of this project was to evaluate the effects of a set of standard treatments in a large integrated study that significantly enhances the ability to detect significant effects of the varying factors*

METHODS

A factorial designed experiment was conducted at all four locations of the Soybean Management Field Days. These locations were near Minden, Pierce, York, and Waterloo, Nebraska. The Minden and Pierce sites were no-tilled while York and Waterloo received a tillage operation prior to planting. Soybeans were planted at all four sites were irrigated and maintained with adequate moisture to ensure high yield production. The soybean variety used was NKS28-K1, and planted at 180 K seeds/A. The actual design was complicated and is called a split plot alpha lattice design with incomplete blocks. This is used when there are a lot of treatments. In this case there were 60 treatments (2 row spacings x five early season treatments x six pod set treatments). This design reduces the effect of soil property changes of the large experimental area. There were two replications at each site, and each replication had two plots with the same treatment. The study was a split plot with blocks of 15 and 30 in row spaced soybeans; the other treatments were randomized within the row spacing blocks. Each treatment unit was 10 ft wide and 30 ft long. Overall management and soil type information is provided in the table on the inside cover of this booklet. Information about the water balance is given in more detail in the irrigation report. A summary is given in Table 18.

Preseason soil samples were collected at each SMFD location, for the general area. One sample from 0-8 in. was taken at random over the whole area. The results are given in Table 9. Overall plot fertility was in the adequate to high range for all nutrients (except boron at Pierce) so no blanket fertility was applied, except what was applied in the treatments.

Evaluated Inputs.

The entire study was conducted in both 15 and 30 inch row spacing at each location. Early season inputs included seed treatments, early season nitrogen and combinations of the two. Inputs at pod set included fungicide, insecticide fertility and a combination of the individual products. A complete list of the treatment details for each product and input is in Table 10. The selection of the chemistry tested in this study is not an indication that this is the best product; it is intended to be representative of a product group. For example, we have selected Stratego YLD as a fungicide input at R3. This product could be comparable to other fungicides which have a strobilurin included in their composition.

Table 9. Soil analysis results from spring soil samples (0-8 in.) taken over the whole Soybean Management Field Day site in April prior to planting in 2013. Information in ppm unless indicated.

Soil Property	Minden	Pierce	Waterloo	York
CEC (me/100g)	13.4	22.0	12.0	20.2
pH	6.7	7.8	5.6	6.7
Buffer pH	NA	NA	6.7	NA
OM (%)	2.5	1.9	2.1	3.3
Nitrates (lb/8 in.)	45	21	30	13
P (Mehlich 3)	138	37	715	36
K	786	204	860	465
Sulfate	30	9.0	16	51
Zn	3.0	5.5	5.0	1.9
Fe	83	24	178	34
Mn	12.0	7.8	13.0	10.0
Boron	1.0	0.44	0.65	--

Soil Fertility Inputs. Early season (V2) nitrogen was applied at 15 lbs N/A as UAN (28-0-0) with drop nozzles between the rows after soybean emergence. The drop nozzles were 15 and 30 inches apart for the two row spacings to ensure the application was made in the center between the rows. For the added fertility at growth stage R3, the two products used were Nachurs N-Rage™ which contains nitrogen, phosphorus, potash, and manganese. This was combined with Nachurs Soy Grow™ which is a combination of several micronutrients.

Data Collection. Plant populations were assessed by counting the total number of plants in two 10 ft. sections of row in each plot. Plots were evaluated for foliar diseases and insect defoliation on a linear percentage scale of 0-100 with 0=no disease or insect feeding present. Assessment was a total percentage of canopy damage or injury and for percent green it is the total percent green in the plot. Differences at locations for percent green are because of differences in assessment timing relative to crop maturity. The only disease observed in these studies was brown spot at relatively low levels. At maturity, plots were rated for percent green canopy on a linear percentage scale. Yield was determined with a small plot combine and all yields were adjusted to 13% grain moisture. The two middle rows were harvested for yield in the 30" plots. The combine head was modified to push down the middle row in the 15" row plots. The two 15" rows were adjusted to take this into account.

Immediately after harvest, soil samples were taken at each site. Four cores were taken at random within each replication at 0-8 in, 8-24 in, and 24-48 in depths. The surface (0-8 in) sample was analyzed for all relevant nutrients, pH, base saturation, organic matter and electrical conductivity. All analysis was conducted by Ward Laboratories (Kearney, NE). The results are given in Appendix Table 1.

Statistical analysis. The analysis of the experiment is on-going, but in order to have a report for growers to use for the 2014 cropping season we are presenting the current analysis. The experimental data was analyzed by individual site as a split plot, and also as a combined experiment. Only the yields were analyzed as an alpha-lattice design. For the most part, the sites were different, and the best approach to understanding the data is to determine the effects of row spacing, early season treatments and pod set treatments for each site. Tables 11-17 are set up to show the means for each variable for each site, the overall means for the treatments across all locations, and the appropriate statistics. The Appendix Tables 2 and 3 show the results from the Analysis of Variance for the interaction effects for yield and Brown Spot. There were few interactions, and the rest of the results are not reported.

Table 10. Specific treatments tested in the 2013 SMFD factorial experiment that were "Early Season Inputs" and "Pod Set Inputs". All seed treatments were applied to the seed prior to planting and all foliar applications were applied in a 15 gal. /A application volume.

Early Season Inputs	Pod Set (Stage R3) Inputs
No Treatment	No Treatment
Fungicide Seed Treatment (ST) (Apron XL 7.5 g/100 kg seed + Maxim 4FS 2.5 g/100 kg seed + Vibrance 2.5 g/100 kg seed)	Fungicide (Stratego YLD 4.0 fl oz/A)
Nitrogen (N) (15 lb N as 28-0-0 applied at growth stage V2)	Fertility [UAN (28-0-0) 25 lb N/A +N-Rage (23-4-2, slow release N plus Mn) 1 gal/A + Soy Grow (0.04 Fe EDTA, 0.05 Mg EDTA, 0.27 Mn EDTA, 0.16 Zn EDTA) 1 pt/A]
Fungicide ST + N (Apron XL 7.5 g/100 kg seed + Maxim 4FS 2.5 g/100 kg seed + Vibrance 2.5 g/100 kg seed) + (15 lb N as 28-0-0 applied at growth stage V2)	Fungicide + Fertility (Stratego YLD 4.0 fl oz/A) +[UAN (28-0-0) 25 lb N/A +N-Rage (23-4-2, slow release N plus Mn) 1 gal/A + Soy Grow (0.04 Fe EDTA, 0.05 Mg EDTA, 0.27 Mn EDTA, 0.16 Zn EDTA) 1 pt/A]
Fungicide ST + Insecticide ST +N (Apron XL 7.5 g/100 kg seed + Maxim 4FS 2.5 g/100 kg seed + Vibrance 2.5 g/100 kg seed + Thiamethoxam 50 g/100 kg seed) + (15 lb N as 28-0-0 applied at growth stage V2)	Fungicide + Insecticide (Stratego YLD 4.0 fl oz/A + Leverage 360 2.8 fl oz/A)
	Fungicide + Insecticide + Fertility (Stratego YLD 4.0 fl oz/A + Leverage 360 2.8 fl oz/A) +[UAN (28-0-0) 25 lb N/A +N-Rage (23-4-2, slow release N plus Mn) 1 gal/A + Soy Grow (0.04 Fe EDTA, 0.05 Mg EDTA, 0.27 Mn EDTA, 0.16 Zn EDTA) 1 pt/A]

RESULTS

End of season soil analysis for the SFMD combined trial shows that all sites were within normal ranges for most of the parameters. Some exceptions occurred, such as all sites except Pierce had very high soil potassium levels. Only the York site had phosphorus levels near the critical level, but at York, the levels were still considered high.

Row spacing. The effect of row spacing was significant at three of the four locations (Table 11). At two locations (Pierce and Waterloo) the 15 inch spacing was higher in yield and at Minden the 30 inch spacing was higher. Because of the differences between sites the overall analysis showed row spacing as insignificant. Over the four locations the average difference was 0.9 bu/A (Prob >F = 0.58).

Early Season Inputs. Soybean populations were affected significantly by the early season inputs at two of the four locations and in the overall average analysis (Table 12). With the exception of Waterloo, stands were greater than 125,000 plants per acre. The significant population differences are not considered agronomically significant. At the Waterloo site, we discovered some of the planter units were not functioning properly. The soil/field condition was very fluffy and soft and seed/soil contact may have been poor. The cooperating farmer commented that part of the reason for poor emergence was due to the deeper planted soybeans tended to have a hard time emerging since the soil tended to crust over once it rains.

Seed treatment fungicides increased stand significantly where we observed effects of the treatments and the average across the four locations was higher in the seed treatment fungicide compared to the "no treatment".

There also was not a significant effect of early season inputs observed at any specific location or across all locations for yield (Table 13). In three of the four locations, the highest average yields were in the "No Treatment" (Table 13). York was the only site where the 'No Treatment" treatment was not the highest yielding. At York the Fungicide + Insecticide treatment was. Across the whole experiment all treatments yielded with a bushel and averaged about 71 bu/A.

Pod Set Inputs. There were overall very low levels of brown spot observed at the trail locations (Table 14). At 21 -28 days after the pod set application, the severity was less than 10% in all locations. Even with the low disease severity there were significantly lower levels in the fungicide treated plots at 3 of the 4 locations. In all locations the "No Treatment" plots had the highest level of severity. Insect pressure was low as evidenced by the defoliation ratings shown in Table 15. End of season percent green, sometimes an indicator of the efficacy of fungicide/insecticide treatments did not show differences (Table 16).

Fertility. Because there were no significant differences for the early or pod set treatments, there is no evidence that these treatments would be cost effective. The rates of nitrogen and the additional treatments were fairly low. In the companion study on high nitrogen rates yields were influenced, but the nitrogen rates were very high. None of the R3 treatments effected yield (Table 17).

DISCUSSION

There was an indication that some factors tested increased yields. The row spacing data collected for yields indicated nearly the same yields for both row spacings, but this was due to one site where 30 inch rows were higher yielding than the 15 inch rows. Looking over other studies in the region, 15 inch rows typically yield higher than the 30 inch rows, but year to year and site to site variation does not guarantee greater yields in all years.

In the trials conducted here, there was no effect of early season inputs on final yields. However, recommendations are not based on one year's results, even at multiple locations. For these reasons, individual field conditions and the field history should be considered when making a decision on using an early season input. In 2013, actual soil conditions were conducive for some seedling disease problems and stands were slightly reduced (139K) from the planted population (180K). In fields with lower initial seeded populations there may be a greater effect as we typically see greater differences with seed treatments in low populations scenarios when seedling disease is present. Even with the reduced populations, we did not detect a significant effect. It is possible that some of the effects of treatments were diluted based on saturated soil conditions and early season moisture availability. In addition, earlier planting into cooler soils might have put more pressure from soil borne diseases, and hence these treatments might have had more impact.

Pod set inputs did not perform well in this trial series and based on these results it would not appear to be a viable way to increase yields. However, based on previous years we have seen good responses in some studies with the fungicide and insecticide applications.

Based on the data and observations of the four locations in 2013, the best way to maximize soybean yields and decrease costs is to use no additional treatments. These same inputs may perform differently in different years and different environments. This study was controlled and replicated, so the comparison between treatments is direct. Because of the number of different classes of inputs (fertility, fungicide, insecticide, row spacing) levels of inputs and choice of specific chemistry was limited. Soybean farmers should consider what they have seen in past years when trying to make decisions on inputs. Overall, the 2013 season was very conducive for good soybean production and outside a few areas that had late season drought issues; our yields were high across Nebraska. The locations for these studies had very good fertility and great soil moisture as evident in Table 18. More experimental data should be considered when trying to make decisions on the value of the treatments tested, as many farmers have observed increased yields from these products. When examining any research the design and precision of the study is extremely important in understanding the value of the reported results. Location, environment, soil type and many other variables all contribute to finalizing a maximum yield plan for soybean production.

Table 11. Yield results for the effect of row spacing at each of the 2013 SMFD locations and overall average yields.

Row Spacing (in.)	Location and Yield (bu/A)				
	Minden	Pierce	Waterloo	York	Average
15	74.3	72.2	64.8	73.8	71.3
30	79.0	70.5	57.1	74.8	70.4
Prob >F	0.04	0.01	0.02	0.15	0.58
CV (%)	7.0	6.8	20	8.2	11
LSD (α=0.05)	1.4	1.2	3.1	1.6	1.0

Table 12. Harvest soybean populations for the early season inputs at each 2013 SMFD location and overall average yields.

Early Season Input	Location and Population (plants/A)				
	Minden	Pierce	Waterloo	York	Average
No Treatment	137,400	164,900	101,600	128,400	133,000
Fungicide Seed Treatment (ST)	150,500	166,900	110,000	139,700	141,800
Nitrogen (N)	130,800	158,100	94,700	137,600	130,300
Fungicide ST + N	146,500	166,500	125,600	137,400	144,000
Fungicide ST + Insecticide ST + N	143,700	167,500	127,600	140,800	144,900
Prob >F	0.0037	0.53	< .0001	0.099	< .0001
CV (%)	19	18	22	18	19
LSD (α=0.05)	10,800	12,000	9,800	9,700	5,400

Table 13. Yield results for the early season inputs at each 2013 SMFD location and overall average yields.

Early Season Input	Location and Yield (bu/A)				
	Minden	Pierce	Waterloo	York	Average
No Treatment	76.0	70.5	62.1	74.2	70.7
Fungicide Seed Treatment (ST)	75.7	71.4	59.7	75.0	71.0
Nitrogen (N)	78.0	72.1	59.2	74.6	71.0
Fungicide ST + N	76.9	71.3	62.9	74.0	71.4
Fungicide ST + Insecticide ST + N	76.8	71.6	60.5	73.7	71.3
Prob >F	0.29	0.65	0.52	0.85	0.90
CV (%)	7.0	6.8	20	8.2	11
LSD (α=0.05)	2.2	2.0	4.9	2.5	1.6

Table 14. Brown Spot Severity ratings at 21 -28 days after application for the pod set inputs at each 2013 SMFD location and overall average severities.

Pod Set (Stage R3) Inputs	Location and Brown Spot Severity[y] (%)				
	Minden	Pierce	Waterloo	York	Average
	30 DAA[z]	30 DAA	28 DAA	29 DAA	
No Treatment	1.9	6.7	6.6	4.2	4.8
Fungicide	2.1	4.7	3.8	2.4	3.3
Fertility	2.0	7.8	5.4	4.0	4.8
Fungicide + Fertility	2.0	5.7	5.4	3.5	4.1
Fungicide + Insecticide	2.3	5.1	5.4	2.7	3.9
Fungicide + Insecticide + Fertility	2.3	4.6	5.6	3.3	3.4
Prob >F	0.311	0.0027	0.0014	0.015	< 0.0001
CV (%)	52	72	70	79	75
LSD (α=0.05)	0.474	1.8	1.6	1.2	0.67

[z] DAA: Number of days after application

[y] Estimated across the entire plant canopy of the two center rows of each plot on a percentage scale (0-100%)

Table 15. Insect Defoliation Severity results for the pod set inputs at each 2013 SMFD location and overall average severities.

Pod Set (Stage R3) Inputs	Location and Insect Defoliation Severity[y] (%)				
	Minden	Pierce	Waterloo	York	Average
	30 DAA[z]	30 DAA	28 DAA	29 DAA	
No Treatment	7.9	5.7	6.3	8.1	7.0
Fungicide	8.1	5.8	6.5	8.3	7.2
Fertility	8.1	6.4	7.2	8.9	7.7
Fungicide + Fertility	7.9	5.5	5.7	8.5	6.9
Fungicide + Insecticide	7.8	4.3	3.4	6.8	5.5
Fungicide + Insecticide + Fertility	6.8	3.8	4.2	7.5	5.6
Prob >F	0.13	<.0001	<.0001	0.0038	< 0.0001
CV (%)	32	46	41	32	37
LSD (α=0.05)	1.1	1.1	1.0	1.1	0.54

[z] DAA: Number of days after application

[y] Estimated across the entire plant canopy of the two center rows of each plot on a percentage scale (0-100%)

Table 16. Percent Green Canopy at maturity for the pod set inputs at each 2013 SMFD location and overall average percent green.

Pod Set (Stage R3) Inputs	Location and Percent Green Canopy (%)[y]				
	Minden	Pierce	Waterloo	York	Average
No Treatment	3.5	3.2	22	1.8	7.7
Fungicide	3.4	4.2	20	2.3	7.5
Fertility	3.8	3.9	18	1.8	7.0
Fungicide + Fertility	4.4	4.6	23	1.8	8.5
Fungicide + Insecticide	3.3	4.6	18	2.1	6.9
Fungicide + Insecticide + Fertility	3.1	4.2	19	2.0	7.0
Prob >F	0.55	0.24	0.38	0.83	0.33
CV (%)	92	73	66	107	95
LSD (α=0.05)	1.5	1.3	5.9	0.92	1.5

[z] DAA: Number of days after application

[y] Estimated across the entire plant canopy of the two center rows of each plot on a percentage scale (0-100%)

Table 17. Yield results for the pod set inputs at each 2013 SMFD location and overall average yields.

Pod Set (Stage R3) Inputs	Location and Yield (bu/A)				
	Minden	Pierce	Waterloo	York	Average
No Treatment	78.2	71.9	63.4	73.1	71.7
Fungicide	77.6	71.4	60.4	73.9	70.9
Fertility	75.9	70.6	63.5	73.9	71.0
Fungicide + Fertility	76.4	71.2	57.8	75.5	70.1
Fungicide + Insecticide	75.5	71.7	60.4	76.0	70.9
Fungicide + Insecticide + Fertility	76.4	71.4	59.8	73.4	70.3
Prob >F	0.19	0.905	0.245	0.213	0.576
CV (%)	7.0	6.8	20	8.2	11
LSD (α=0.05)	2.37	2.17	5.37	2.71	1.72

Table 18. Soil water balance for each location of the 2013 SMFD trials.

Soil Water Balance	Minden	Pierce	Waterloo	York
Beginning Soil Water (in.)	4.4	2.5	2.0	4.4
Ending Soil Water (in.)	3.0	1.1	1.8	3.7
Water Used from Soil (in.)	1.4	1.4	0.2	0.7
Rainfall and Irrigation (in.)	20.7	21.8	24.1	26.1
Total Crop Water Use (in.) (Evapotranspiration)	17.1	17.9	16.3	16.9
Total Water Consumed (in.)	22.1	23.2	24.3	26.8

Appendix Tables:

Appendix Table 1. End of season soil property assessment of 2013 SMFD sites.				
	(in ppm unless otherwise noted)			
Soil Property	Minden	York	Pierce	Waterloo
CEC (me/100g)	16.4	17.2	20.9	12.5
% H Sat	0	0	0	31
% K Sat	10	5	3	12
% Ca Sat	66	77	89	44
% Mg Sat	22	16	8	12
% Na Sat	2	2	0	1
pH	6.8	6.9	7.7	5.6
Buffer pH	7.2	7.2	7.2	6.6
1:1 S Salts mmho/cm	0.47	0.29	0.29	0.21
OM (%)	2.5	2.9	1.9	3.0
Nitrates (0-8") ppm	4.6	3.3	2.8	3.7
P (Mehlich 3)	141	18	26	524
K	603	340	181	601
Sulfate	34.0	12.8	9.3	81.3
Zn	4.91	1.62	3.03	4.40
Fe	68.6	28.5	16.2	149.5
Mn	8.7	12.1	9.0	10.1
Cu	1.25	0.62	0.66	1.36
Ca	2183	2651	3742	1100
Mg	435	335	198	183
Na	81.0	57.8	13.8	24.5
Soil nitrates				
0-8" Nitrates (lbs/A)	10.8	8.0	6.5	9.0
8-24" Nitrate (lb/A)	8.0	16.8	9.3	48.0
24-48" Nitrate (lb/A)	9.0	18.3	5.8	31.3
0-48" nitrate (lb/A)	28	43	22	88

Appendix Table 2. ANOVA interaction effects for row spacing, early and late season treatments on yield for 2013 SMFD locations.

Interaction Effects	Location and Prob >F for Yield (bu/A)				
	Minden	Pierce	Waterloo	York	Average
rs*seedtrt	0.0205	0.931	0.355	0.419	0.524
rs*foliar	0.606	0.359	0.713	0.499	0.570
seedtrt*foliar	0.0207	0.244	0.379	0.427	0.189
rs*seedtrt*foliar	0.0930	0.872	0.401	0.153	0.874

Appendix Table 3. ANOVA interaction effects for row spacing, early and late season treatments on Brown Spot severity for 2013 SMFD locations.

Interaction Effects	Location and Prob >F for Brown Spot Severity				
	Minden	Pierce	Waterloo	York	Average
rs*seedtrt	0.0819	0.0837	0.832	0.945	0.337
rs*foliar	0.250	0.658	0.732	0.474	0.739
seedtrt*foliar	0.501	0.381	0.808	0.601	0.474
rs*seedtrt*foliar	0.178	0.711	0.583	0.514	0.363

SMFD 2013 Study - Herbicide Efficacy and Droplet Size as Influenced by Adjuvants

Cody F. Creech (UNL Graduate Student), William E. Bagley (Manager of Application Technology, Wilbur-Ellis Company), Lowell D. Sandell (UNL Weed Science Educator), and Greg R. Kruger (UNL Extension Cropping System Specialist)

TAKE HOME POINTS:

- All herbicides in this study had increased efficacy with at least one adjuvant.
- Adjuvants are intended to compliment herbicides, not to replace them.
- Adjuvants should be used if they are recommended on the herbicide label.
- Adjuvants are herbicide and species specific. There is no one adjuvant that can do it all.
- Depending on the herbicide formulation, a DRT may or may not increase droplet size.
- Adjuvants do impact droplet size and therefore have impacts on drift and in some cases herbicide efficacy

Introduction

Adjuvants serve many unique roles in pesticide applications. Adjuvants are commonly used to improve the potential activity of postemergence herbicides that are otherwise often limited by the ability of the herbicide to adequately cover or penetrate the leaf surface. Many herbicides are improved by adjuvants. Additionally, many adjuvants exist on the market for use in pesticide applications. Furthermore, information on pesticide labels are generally limited in describing the use of adjuvants to optimize herbicide performance, while there are certainly some pesticide labels that clearly describe the type of adjuvants to use to maximize the performance of the pesticide being used. Most labels will suggest 2-3 different types of adjuvants and leave the decision up to the applicator as to which one to use. However, as many people realize, not all adjuvants are the same and each adjuvant works slightly differently with the pesticide.

When an applicator goes to apply a pesticide, the applicator must consider a series of different questions: What will the addition of an adjuvant to the tank-mixture do to the droplet size of the spray? Which adjuvants will have the greatest improvement of the efficacy of the pesticide being applied? Can pesticide loss be minimized with the use of an adjuvant? Are there situations when one pesticide will work better than another? And maybe many others questions could come to mind.

Non-ionic surfactant (NIS). Non-ionic surfactants typically improve the activity and efficacy of the spray application by reducing surface tension and increasing both coverage and penetration of the herbicide into the plant. Non-ionic surfactants, commonly referred to as wetting agents, are most commonly used with contact pesticides, but can also improve the activity in some systemic based products. Non-ionic surfactants are a popular choice in many applications because of the low use rates that they are commonly used at (2 pt/acre or less or 0.25% v/v).

Crop oil concentrate (COC). Crop oil concentrates are highly petroleum-based oils designed to increase herbicide retention and reduce drying time. Much like the non-ionic surfactants, crop oil concentrates increase pesticide penetration and decrease spray solution surface tension. Crop oil concentrates are generally formulated to also have some of the wetting, dispersing, and penetrating characteristics of some of the other adjuvants through mixing the oils with small amounts of other adjuvants. Crop oils are commonly used with postemergence herbicides to help the herbicides break through waxy leaf surfaces or penetration of the cuticle on plants which are difficult to control. Crop oil concentrates will sometimes be tabled in favor of non-ionic surfactants in postemergence applications because they have a greater potential to cause damage to the crop.

Methylated seed oil (MSO). Methylated seed oils are modified vegetable oils that improve transportation through the waxy cuticle found on leaf surfaces. Methylated seed oils are multifunctional spray concentrates with wetting and penetrating properties that have low use rates and offers excellent crop tolerance. Methylated seed oils are very similar to crop oil concentrates, but are generally thought to have better performance with systemic herbicides likely because they are perceived to have better cuticle penetration. They are commonly used with postemergence pesticide applications, plant growth regulator applications, and fertilizer applications.

High surfactant oil concentrate (HSOC). High surfactant oil concentrates are one of the newer classes of adjuvants. High surfactant oil concentrates are generally considered nonionic emulsifiable crop oil concentrates usually consisting of 80% surfactant and 20% oil or another similar ratio. High surfactant oil concentrates combine the benefits of non-ionic surfactants and crop oil concentrates.

Ammonium sulfate (AMS). Ammonium sulfate is promoted to overcome the antagonism with hard water and also improves the uptake of some herbicides. AMS is most widely promoted with glyphosate applications, but it is also commonly used with other herbicides as well.

Drift reduction technology (DRT). DRT adjuvants are used to reduce the number of fine droplets. In some cases, drift retardants may cause significant increases in the average droplet size of the spray plume. Drift retardants are generally not thought to have a large impact on efficacy of different pesticides, but there are two ways in which they can impact efficacy indirectly. The first is that a greater amount of the product is deposited in the application area increasing efficacy. The other effect is from the shift in droplet size which can which can be either positive or negative depending on the pesticide being applied and the droplet size of the spray.

During the summer of 2013, a field study was conducted at the Soybean Management Field Day locations to evaluate the impact of different types of adjuvants on droplet size and herbicide efficacy of four commonly used postemergence soybean herbicides.

Methods

Replicated studies were conducted at the 2013 Soybean Management Field Days sites in Minden, York, Pierce, and Waterloo, NE. The treatments consisted of four herbicides: Touchdown HiTech (a glyphosate formulation with no surfactant) at 32 oz/acre, Fusilade at 6 oz/acre, Cobra at 12.5 oz/acre and Clarity at 8 oz/acre. These four herbicides represented an EPSP synthase inhibitor, ACCase inhibitor, PPO inhibitor, and a synthetic auxin, respectively. Each herbicide was applied alone and in combination with a non-ionic surfactant (NIS), crop oil concentrate (COC), methylated seed oil (MSO), high surfactant oil concentrate (HSOC), ammonium sulfate (AMS), and a drift reduction technology adjuvant (DRT) (Table 19). The adjuvants were applied at the following rates: NIS (0.25% v/v), COC (1% v/v), MSO (1% v/v), HSOC (1% v/v), AMS (17 lbs/100 gal), and DRT (4 fl oz/a). Plots were 3 meters wide and 8 meters long and had a naturally occurring weed population that was supplemented by broadcasting velvetleaf (*Abutilon theophrasti*), grain amaranth (*Amaranthus hypochondriacus*), Palmer amaranth (*Amaranthus palmeri*), flax (*Linum usitatissimum*), and barnyard grass (*Echinochloa crus-galli*). The Touchdown HiTech, Fuslilade, and Clarity were applied at 10 GPA using an AIXR 110015 nozzle and the Cobra was applied at 20 GPA using an AIXR 11003 nozzle. Treatments were applied using a CO_2 pressurized backpack sprayer. Visual estimations of injury were collected at 7, 14, and 28 days after treatment (DAT) using a scale of 0 – 100 where 0 = no injury and 100 = plant death.

Table 19. Treatment list for adjuvant combinations used in the 2013 SMFD trials.

Treatment	Adjuvant	Rate
1	Nonionic surfactant (NIS)	0.25% v/v
2	Crop oil concentrate (COC)	1% v/v
3	Methylated seed oil (MSO)	1% v/v
4	High surfactant oil concentrate (HSOC)	1%v/v
5	Ammonium sulfate (AMS)	17 lb ai/100 gal
6	Drift reduction technology (DRT)	4 fl oz/a
7	None	

Results

Generally, the addition of adjuvants increased the efficacy of the four herbicides tested when compared to the herbicide alone. The adjuvants performed differently with each herbicide and were often species specific and occasionally location specific (although results are combined across location for the purpose of reporting here). The addition of adjuvants is imperative to get the most out of every herbicide application, but further testing is needed to understand which situations are best suited for different application conditions and intended targets.

All adjuvants except NIS increased the droplet size and reduced the potential for drift with glyphosate (Table 20). Pesticide applicators using glyphosate should be aware that most glyphosate formulations contain surfactants of some type so the drift potential of most glyphosate formulations without the addition of other adjuvants is likely to have a high drift potential. The use of AMS improved control of all species evaluated showing why recommendations for glyphosate applications are recommended with AMS.

Table 20. Visual estimations of injury of glyphosate treatments using a scale of 0 – 100 where 0 = no injury and 100 = plant death.

Trt	Dv50	Barnyard grass	Flax	Grain amaranth	Palmer amaranth	Velvetleaf
	µm			%		
NIS	313	66a	59a	83b	81b	50b
COC	396	64ab	50b	80bc	79bc	47cb
MSO	368	67a	48bc	78bc	78bc	43c
HSOC	355	69a	43cd	82b	80b	47cb
AMS	388	66a	38d	90a	90a	66a
DRT	379	59bc	38d	78bc	76bc	47cb
None	337	46c	22e	75c	74c	43c

Letters indicate significant differences (α=0.05) within species.

Cobra is a contact herbicide and COC is commonly recommended for applications with this herbicide (Table 21). Droplet size did not vary as significantly with adjuvants mixed with Cobra as what it did for the TouchDown HiTech. The NIS, MSO and HSOC also improved control observed with Cobra. The DRT did not have a large impact on droplet size over the Cobra alone.

Table 21. Visual estimations of injury of Cobra treatments using a scale of 0 – 100 where 0 = no injury and 100 = plant death.

Trt	Dv50	Barnyard grass	Flax	Grain amaranth	Palmer amaranth	Velvetleaf
	µm			%		
NIS	480	9	16abc	47abc	46ab	22abc
COC	484	11	21a	52a	51a	26a
MSO	467	8	16abc	46bc	44bcd	21abc
HSOC	518	10	19ab	51ab	50a	24ab
AMS	482	8	12bc	45bcd	45abc	18c
DRT	492	8	13bc	42cd	40cd	20bc
None	481	9	10c	40d	39d	18c

Letters indicate significant differences (α=0.05) within species.

The adjuvants tested all improved control of Clarity on grain amaranth, but had no effect on the other broadleaf species tested (Table 22). The COC, MSO, HSOC and DRT all had significant effects on droplet size and would work well for reducing drift of Clarity. Because Clarity is a systemic based product the reduced drift may have as much meaning to applicators as the improved efficacy. Clarity is also an example of why applicators must be cognizant of the species that they are targeting when making decisions on which adjuvants to use.

Table 22. Visual estimations of injury of Clarity treatments using a scale of 0 – 100 where 0 = no injury and 100 = plant death.

Trt	Dv50	Flax	Grain amaranth	Palmer amaranth	Velvetleaf
	µm		%		
NIS	317	11	32ab	33	18
COC	390	11	33a	33	16
MSO	370	11	30ab	30	17
HSOC	371	10	30ab	30	19
AMS	342	11	31ab	31	16
DRT	371	13	31ab	32	17
None	328	9	27b	29	15

Letters indicate significant differences (α=0.05) within species.

Only COC and MSO improved the performance of Fusilade on barnyard grass (Table 23). No other species were evaluated for control because the other herbicides in the study were broadleaf herbicides. Additionally, the DRT and other adjuvants had little or no improvement on fines or average droplet size so the use of the adjuvants tested are probably not a good investment for drift management.

Table 23. Visual estimations of injury of Fusilade treatments using a scale of 0 – 100 where 0 = no injury and 100 = plant death.

Trt	Dv50	Barnyard grass
	µm	%
NIS	359	18abc
COC	377	24a
MSO	356	23ab
HSOC	363	22abc
AMS	393	16c
DRT	393	18abc
None	382	17bc

Letters indicate significant differences (α=0.05) within species.

Discussion

In Nebraska, it is highly recommended that applicators use AMS at 17 lbs/100 gal for glyphosate applications. The addition of AMS to the glyphosate in our study increased the control of the velvetleaf and amaranth species. However, flax, which has a much smaller and fleshier leaf, did not show as much improvement with AMS. The addition of a surfactant or oil, especially NIS, increased the control of flax which is why it is recommended to use a surfactant loaded glyphosate formulation or surfactant with an unloaded formulation. Many glyphosate formulations come preloaded with surfactants. The amount of surfactant in the formulation is not generally reported so applicators should be cautious and add surfactant if there are noticeable performance failures and the reason for the failure is unknown.

All of the herbicides tested in this study responded to the addition of adjuvants, however, which adjuvant improved the performance of the herbicide depended on the herbicide being tested and the species being targeted. If a herbicide label recommends adding an adjuvant, one of the recommended adjuvants should strongly be considered. When deciding what to use, consider the weed species in the field, the morphology of the weeds, and the weather conditions. Once an applicator has decided on an adjuvant that will maximize the application, use of the full recommended rate of the adjuvant is strongly encouraged.

Adjuvants play an important role in pesticide applications, but buyers should be aware that while some adjuvants are advertised to allow the applicator to “reduce the rate” of the pesticide being applied, this is a dangerous proposition. Adjuvants should be view as tools to improve performance or reduce unintended effects, not to replace the pesticide needed. Reducing the pesticide rates being applied can lead to variable performance and/or pesticide resistance.

Soybean Management Field Day Irrigation Management Trial

Chuck Burr (UNL Extension Educator), Gary Zoubek (UNL Extension Educator),
James Specht (UNL Soybean Specialist), and William Kranz (UNL Extension Irrigation Specialist)

TAKE HOME POINTS:

- Irrigation before R3 may produce taller soybean plants that are prone to lodging
- R3 Irrigation Treatment recommended for deep medium or fine textured soils and full soil profile
- Some Irrigation may be required during vegetative growth stages on sandy and sandy loam soils
- Highest Water Use Efficiency achieved by 50% Irrigation Treatment

Introduction

Soybean acreage in Nebraska has increased from 43,000 acres of irrigated production in 1972 to 2.3 million acres of irrigated production in 2011. With rising fuel costs and declining crop prices soybean growers are looking for ways to reduce operating costs. Following two years of severe drought over much of the state of Nebraska, several Natural Resources Districts have implemented irrigation water pumping restrictions. Over 1.5 million irrigated acres are currently under some form of irrigation water allocation.

Proper irrigation management is critical to optimize both yields and irrigation water use efficiency. Recent UNL research has shown that the optimal time to begin irrigating soybeans is at the R3 growth stage (Irrigating Soybean, NebGuide G1367). Watering before the R3 stage can lead to taller plants which may lodge before harvest. Lodging may impede grain harvesting equipment thus leading to severe yield reductions. Research has also shown that irrigation applications during the vegetative growth stage have little impact on soybean yields. Irrigation applications during the reproductive growth stage have shown to give the most yield response for a limited water supply.

Methods

Soybean plots were laid out with four irrigation treatments and four replications. The variety planted at all four SMFD locations was: Syngenta NK S28-K1. Each soybean plot was four rows wide and twenty feet long with a 30-inch row spacing. A non-irrigated buffer row separated each plot to reduce the possibility of soybean plants pulling soil water from an adjacent irrigation treatment. Plots were watered with a subsurface drip tape laid on the soil surface next to the soybean row. Plumbing with a main line and valves controlled the water application to the four rows in each plot. A set of three Watermark soil water sensors were installed in the first replication to monitor the soil water level in the top three feet of soil. The center two rows of each plot were harvested for yield comparisons.

The four irrigation treatments were as follows:

R2 Irrigation. Irrigation began at the R2 or Full Flower growth stage (at least one flower was present at any main stem node). Subsequent irrigations were scheduled by monitoring soil water and to maintain soil water levels above 35% depletion.

R3 Irrigation. Irrigation was delayed until the R3 or Beginning Pod Elongation growth stage (at least one pod 3/16 inch long is present at any one of the four upper most main stem nodes). Subsequent irrigations were scheduled by monitoring soil water and to maintain soil water levels above 35% depletion.

35% Depletion. Irrigation applications were scheduled to maintain soil water levels above the 35% depletion level throughout the growing season.

50% Depletion. Irrigation applications were scheduled to maintain soil water levels above the 50% depletion level throughout the growing season. This is the typical irrigation scheduling technique promoted in the Irrigating Soybean NebGuide.

Results

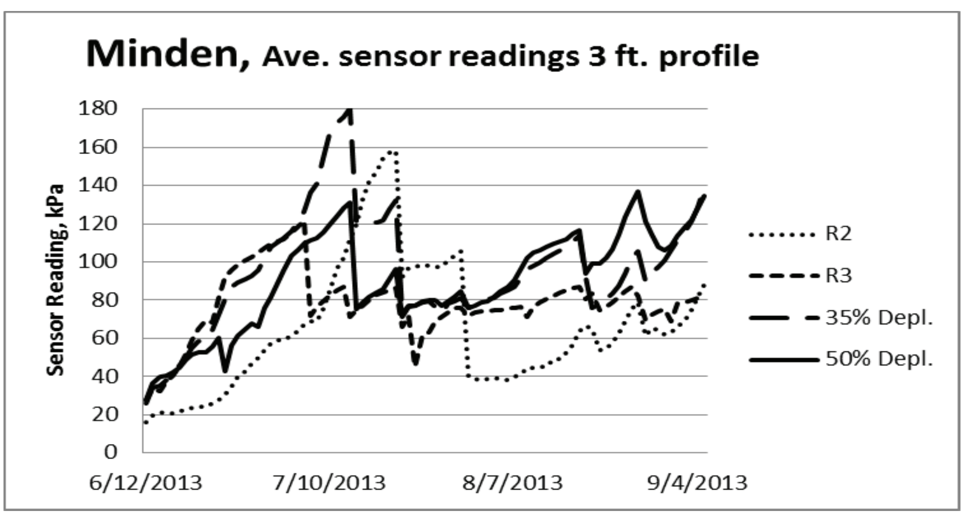
Minden Site

The irrigation plot was located on a dryland pivot corner on a silt loam soil. Yield results for the four treatments ranged from 49.0 to 61.3 with no statistical difference among the water management treatments. All irrigation treatments received 5.9 inches of water, but on different irrigation dates. The soil water depleted from the profile was determined by using the Watermark soil water sensor readings at the beginning of the season and comparing them to the end of the season. A Water Use Efficiency (WUE) was calculated for each treatment. Water use efficiency is a measure of how many bushels of grain were produced divided by the water used from all sources (rainfall, irrigation and soil moisture depletion).

Table 24. Minden site treatments

Treatment	Yield, bu/A	Irrigation, inches	Soil Water Depleted, inches	Water Use Efficiency, bu/inch
35%	60.3	5.9	3.3	2.6
50%	49.0	5.9	3.2	2.1
R2	61.3	5.9	2.4	2.7
R3	52.1	5.9	2.1	2.3
Average	**55.7**	**5.9**	**2.7**	**2.4**
Rainfall, inches	14.3			

Following is a graph of the soil water for each of the irrigation treatments. For a silt loam soil, field capacity has a sensor reading of 18 cb and 50% of field capacity has a sensor reading of approximately 150 cb.



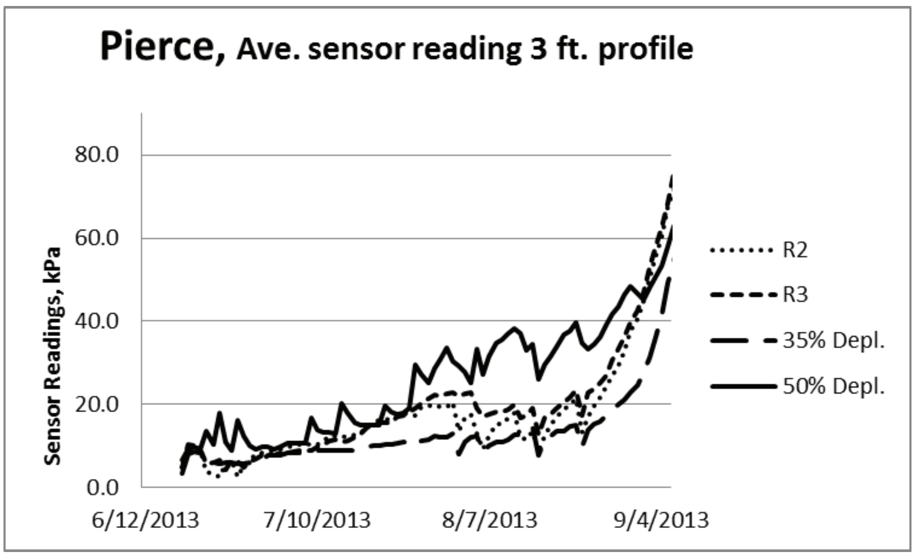
Pierce Site

The irrigation plot was located on a dryland pivot corner on a sandy loam soil. Yield results for the four treatments ranged from 58.2 to 63.8 with no statistical difference. Irrigation treatments received 5.8 to 7.5 inches of water. Soil moisture sensors were used to determine how much soil water was removed from the three foot soil profile.

Table 25. Pierce site treatments

Treatment	Yield, bu/A	Irrigation, inches	Soil Water Depleted, inches	Water Use Efficiency, bu/inch
35%	61.7	6.8	1.8	2.9
50%	62.6	5.8	1.6	3.1
R2	63.8	7.5	1.8	2.8
R3	58.2	6.8	1.8	2.7
Average	**61.6**	**6.7**	**1.7**	**2.9**
Rainfall, inches	13.2			

Following is a graph of the soil water for each of the irrigation treatments. For a sandy loam soil, field capacity has a sensor reading of 7 and 50% of field capacity has a sensor reading of 60.



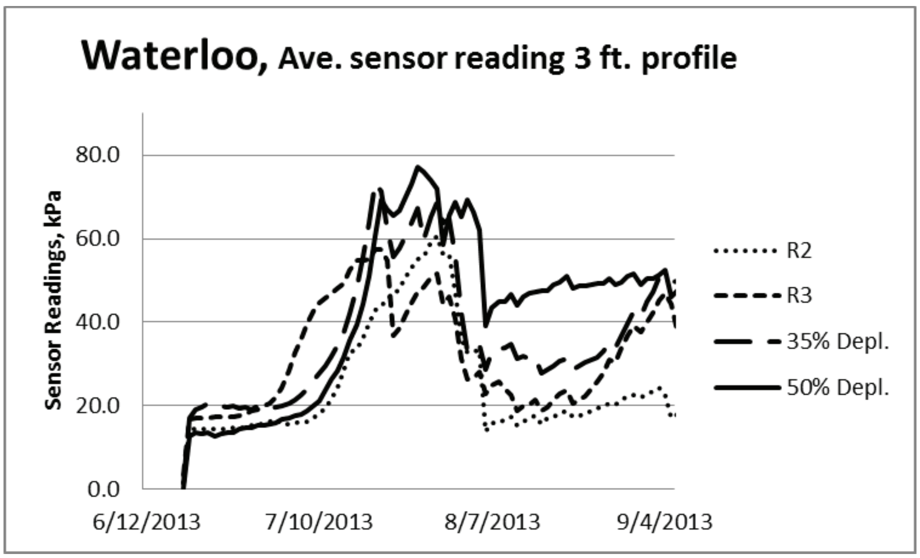
Waterloo Site

The irrigation plot was located on a dryland pivot corner on a loamy sand soil. Yield results for the four treatments ranged from 75.5 to 90.1 with no statistical difference. Irrigation treatments received 7.3 to 8.3 inches of water. Soil moisture sensors were used to determine how much soil water was removed from the three foot soil profile.

Table 26. Waterloo site treatments

Treatment	Yield, bu/A	Irrigation, inches	Soil Water Depleted, inches	Water Use Efficiency, bu/inch
35%	75.5	7.3	0.2	3.2
50%	89.7	7.3	0.4	3.8
R2	90.1	8.3	0.1	3.7
R3	87.4	8.3	0.4	3.6
Average	**85.7**	**7.8**	**0.3**	**3.6**
Rainfall, inches	15.8			

Following is a graph of the soil water for each of the irrigation treatments. For a loamy sand soil, field capacity has a sensor reading of 12 and 50% of field capacity has a sensor reading of 37.



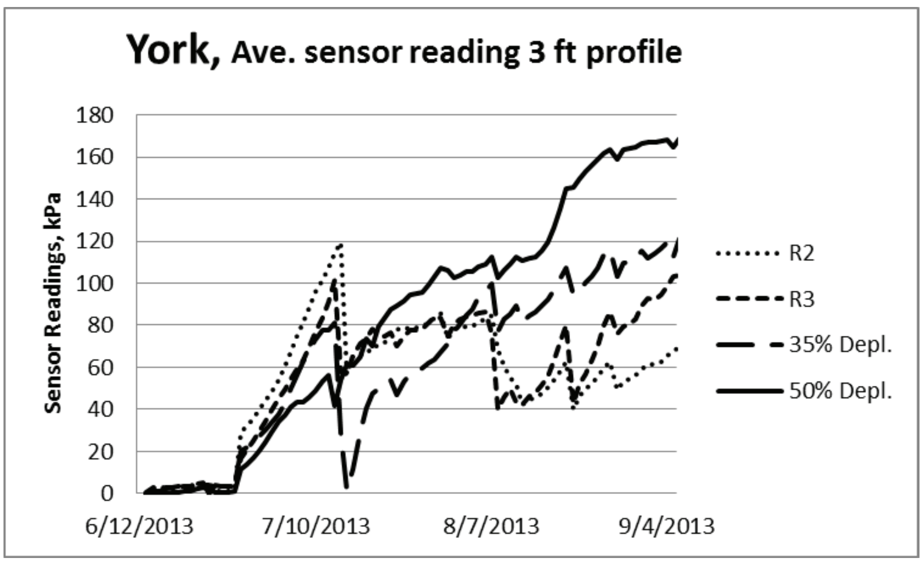
York Site

The irrigation plot was located on a dryland pivot corner on a silty clay loam soil. Yield results for the four treatments ranged from 65.4 to 69.7 with no statistical difference. Irrigation treatments received 5.8 to 7.8 inches of water. Soil water sensors were used to determine how much soil water was removed from the three foot soil profile.

Table 27. York site treatments

Treatment	Yield, bu/A	Irrigation, inches	Soil Water Depleted, inches	Water Use Efficiency, bu/inch
35%	69.7	6.8	1.8	2.7
50%	65.4	5.8	2.0	2.6
R2	67.1	7.8	0.9	2.6
R3	66.2	6.8	1.4	2.7
Average	**67.1**	**6.8**	**1.5**	**2.7**
Rainfall, inches	16.9			

Following is a graph of the soil water for each of the irrigation treatments. For a silty clay loam soil, field capacity has a sensor reading of 17 and 50% of field capacity has a sensor reading of 150.



Discussion

While there were no significant yield differences for any of the irrigation treatments at any site, there were some trends that bear further discussion. The R3 irrigation treatment recommendation from the Irrigating Soybean NebGuide assumes a soil water profile at or near field capacity at the beginning of the crop season and a deep medium or fine textured soil type. At the Minden location, the plot was located in a dryland pivot corner. The third foot of soil was below 50% depletion at the beginning of the season and never did refill completely. This likely resulted in excessive water stress and fewer pods that led to the reduced yields on the R3 Treatment compared to the R2 Treatment. The Pierce and Waterloo sites were located on a sandy loam and loamy sand soil, respectively which do not have enough soil water holding capacity to allow the plants to grow normally to achieve higher yields under the R3 irrigation treatment. Some irrigation may be required before the R3 growth stage on these soil types. This likely was the cause for slightly lower yields in the R3 Treatment compared to the R2 Treatment.

The amount of irrigation water applied at each location was not much different among irrigation treatments. Because of limited rainfall during the month of August, most irrigation treatments required similar applications. The value of using the 50% depletion treatment would be to delay irrigation and hopefully receive rainfall, thereby reducing the amount of irrigation water applied. Regardless of irrigation treatment one should expect 3-3.5 bushels per inch of water applied. With similar irrigation amounts applied, one would expect similar yields.

If you eliminate the Minden location for an abnormally dry soil profile and average the remaining three sites, the data tell a more representative story. The 50% irrigation treatment had slightly lower yields (although not significantly lower) but had a lower irrigation application amount for the season. This treatment had the highest WUE (yield divided by water used) at 3.2 bushels per inch. Based on the tests conducted in 2013, in an irrigation allocation situation, the 50% treatment gave the most yield for a limited amount of water available.

Table 28. Average Yield and Water Use Efficiency for the Pierce, Waterloo and York sites.

Treatment	Yield, bu/A	Irrigation, inches	Soil Water Depleted, inches	Water Use Efficiency, bu/inch
R2	73.3	7.9	0.9	3.1
R3	70.6	7.3	1.2	3.0
35%	69.0	7.0	1.3	2.9
50%	72.6	6.3	1.3	3.2

The picture below shows a York R2 treatment plot that had the valve mistakenly shut off for the final few irrigations. The yield for this plot was 20 bushels lower and was not included in the final results. It does, however, show the impact of watering early and not watering late. If you water beans early, keep full water to them.

See the research in action at Soybean Management Field Days

Watch for details on dates and locations for August 2014

University of Nebraska Lincoln EXTENSION
Know how. Know now.

Soybeans
Nebraska Soybean Board

Our Soy Checkoff
Progress Powered by U.S. Farmers

Soybean Management Field Days

Faculty and staff involved with the on-farm research efforts include:

NICHOLAS ARNESON
Pathology Research Technologist
University of Nebraska–Lincoln Dept. of Plant
Phone: (402) 472-6771
E-mail: nicholas.arneson@unl.edu

BILL BAGLEY
Manager of Application Technology
Wilbur-Ellis Company
E-mail: BBagley@wilburellis.com

CHUCK BURR
Extension Educator
University of Nebraska–Lincoln
402 West State Farm Road
North Platte NE 69101-7751
Phone: (308) 696-6783
E-mail: chuck.burr@unl.edu

***ALAN CORR**
Extension Educator
University of Nebraska–Lincoln
P.O. Box 757
Lexington, NE 68850-0757
Phone: (308) 696-6781
E-mail: acorr1@unl.edu

CODY CREECH
Graduate Student
University of Nebraska West Central
Research and Extension Center
402 West State Farm Rd
North Platte, NE 69101
Phone: (435)770-1538
E-mail: cody.creech@huskers.unl.edu

CHERYL DUNBAR
Office Manager
UNL Extension in Saunders County
1071 County Road G * Ithaca, NE 68033
Phone: (402) 624-8003
E-mail: cdunbar2@unl.edu

LOREN GIESLER
Extension Plant Pathologist
University of Nebraska–Lincoln
448 Plant Science Hall
Lincoln, NE 68583-0722
Phone: (402) 472-2559
E-mail: lgiesler1@unl.edu

KEITH GLEWEN
Project Coordinator and Extension Educator
University of Nebraska–Lincoln
1071 County Road G
Ithaca, NE 68033
Phone: (800) 529-8030
or (402) 624-8000
E-mail: kglewen1@unl.edu

THOMAS HUNT
Extension Entomologist
University of Nebraska–Lincoln
UNL Haskell Ag Lab
57905 866 Rd
Concord, NE 57905
Phone: (402)584-3863
E-mail: thunt2@unl.edu

*** Denotes Host County Extension Educator**

BRUCE JOHNSON
Professor of Agricultural Economics
University of Nebraska–Lincoln
314B FYH
Lincoln, NE 68583-0922
Phone: (402)472-179
E-mail: bjohnson2@unl.edu

GREG KRUGER
Extension Cropping System Specialist
University of Nebraska
West Central Research
and Extension Center
402 West State Farm Road
North Platte, 69101-7751
Phone: (308) 696-6715
E-mail: gkruger2@unl.edu

***WAYNE OHNESORG**
Extension Educator
University of Nebraska–Lincoln
601 E Benjamin Ave Ste 105
Norfolk, NE 68701-0812
Phone: (402)370-4044
E-mail: wohnesorg2@unl.edu

MIKE MAINZ
Research Technologist
University of Nebraska
Haskell Agricultural Laboratory
57905 866 Rd
Concord, NE 68728
Phone: 402 584 3847
E-mail: mmainz3@unl.edu

DELORIS PITTMAN
Marketing and Promotions Manager
University of Nebraska–Lincoln Agricultural
Research and Development Center
122 Mussehl Hall
Lincoln, NE 68583-0718
Phone: (402)472-3293
E-mail: dpittman1@unl.edu

LOWELL SANDELL
Weed Science Extension Educator
University of Nebraska–Lincoln
Department of Agronomy and Horticulture
362A Plant Science Hall
Lincoln, NE 68583-0915
Phone: (402) 472-1527
E-mail: lsandell2@unl.edu

RON SEYMOUR
Extension Educator – Entomologist
University of Nebraska–Lincoln
300 N Joseph Ave Rm 103
Hastings, NE 68901-7597
Phone: (402)461-7209
E-mail: ron.seymour@unl.edu

CHARLES SHAPIRO
Extension Soil Scientist - Crop Nutrition
University of Nebraska–Lincoln
Haskell Agricultural
Laboratory
57905 866 Rd
Concord, NE 68728-2828
Phone: (402) 584-3803
E-mail: cshapiro1@unl.edu

JIM SPECHT
Professor of Agronomy and Horticulture
University of Nebraska–Lincoln
322 Keim Hall
Lincoln, NE 68583-0915
Phone: (402) 472-1536
E-mail: jspecht1@unl.edu

STEVE SPICKA
Ag Research Technician
University of Nebraska–Lincoln ARDC
1071 County Road G Ithaca, NE 68033
Phone: (402) 624-8023
E-mail: sspicka2@unl.edu

***MONTE STAUFFER**
Extension Educator
University of Nebraska–Lincoln
501 Olson Dr. Suite 5
Papillion, NE 68046-5752
Phone: (402)444-7804
E-mail: mstauffer1@unl.edu

ROGER YERDON
octor of Plant Health Program
Graduate Student
University of Nebraska–Lincoln D
279E Plant Science Hall
Lincoln, NE 68583-0933 (402) 472-3345
E-mail: rogeryerdon@gmail.com

ROBERT WRIGHT
Extension Entomologist
University of Nebraska–Lincoln
213 ENTO
Lincoln, NE 68583-0816
Phone: (402)472-2128
E-mail: rwright2@unl.edu

***GARY ZOUBEK**
Extension Educator
University of Nebraska–Lincoln
2345 Nebraska Ave
York, NE 68467-1104
Phone: (402)362-5508
E-mail: gary.zoubek@unl.edu

NEBRASKA SOYBEAN BOARD
3815 Touzalin Ave., Suite 101
Lincoln, NE 68507
Phone: (800) 852-2326
E-mail: info@nebraskasoybeans.org

VICTOR BOHUSLAVSKY
Executive Director
Nebraska Soybean Board
3815 Touzalin Ave., Suite 101
Lincoln, NE 68507
Phone: (800) 852-2326
E-mail: victor@nebraskasoybeans.org

ANDY CHVATAL
Industry Relations Specialist
Nebraska Soybean Board
3815 Touzalin Ave., Suite 101
Lincoln, NE 68507
Phone: (800) 852-2326
E-mail: andy@nebraskasoybeans.org

Business assistance provided by the
University of Nebraska
Greater Nebraska Business Center

Soybean Management Field Days
RESEARCH UPDATE

Irrigation installation at SMFD site

Irrigated soybeans at Minden SMFD site

Harvesting at 2013 SMFD sites

2013 Soybean Management Field Days Research Update Report Authors:

William E. Bagley (Manager of Application Technology, Wilbur-Ellis Company), Chuck Burr (UNL Extension Educator), Cody F. Creech (UNL Graduate Student), Loren J. Giesler (UNL Extension Plant Pathologist), Keith Glewen (UNL Extension Educator), William Kranz (UNL Extension Irrigation Specialist, Greg R. Kruger (UNL Extension Cropping System Specialist), Lowell D. Sandell (UNL Weed Science Educator), Charles Shapiro (UNL Extension Soil Scientist – Crop Nutrition), James Specht (UNL Soybean Specialist), and Gary Zoubek (UNL Extension Educator)

For more information, contact the Nebraska Soybean Board at (800)852-BEAN
or University of Nebraska-Lincoln Extension at (800)529-8030.